AMENDMENTS TO THE SPECIFICATION:

Please amend the paragraph on page 4, beginning at line 11 as follows:

On the buffer layer 502, a mesa stripe of InGaAsP wavelength control layer 506, an n type InP intermediate layer 508, an InGaAsP MQW active layer 510 and a p type InP clad layer 512 are formed by being laid one on another in the stated order and etched. A quaternary diffraction grating layer 514 having a diffraction grating formed in is formed between the buffer layer 502 and the wavelength ~~control~~ tuning layer 506.

Please amend the paragraph on page 5, beginning at line 4 as follows:

In the TTG-LD having the above-described structure, the p type electrode 504 formed on the underside of the semiconductor substrate 500 injects current into the wavelength ~~control~~ tuning layer 506 formed below the intermediate layer 508 via the semiconductor substrate 500 and the buffer layer 502. On the other hand, the p type electrode 520 formed on the cap layer 518 injects current into the MQW layer 510 formed on the upper side of the intermediate layer 508 via the cap layer 518 and the clad layer 512.

Please amend the paragraph on page 5, beginning at line 14 as follows:

The intermediate layer 508 is formed between the wavelength ~~control~~ tuning layer 506 and the MQW layer 510 and is connected to the outside earth potential by the n type electrode 522. That is, the intermediate layer 508 connected to the earth potential functions as the common earth

potential of the elements. Thus, the intermediate layer 508 connected to the outside earth potential makes the two functional layers, i.e., the MQW active layer 510 and the wavelength ~~control~~ tuning layer 506 electrically independent of each other. Accordingly, the TTG-LD having this structure controls the current amount injected into the respective functional layers to thereby perform the laser oscillation control and the oscillation wavelength control independent of each other.

Please amend the paragraph on page 6, beginning on line 12 as follows:

Means for compensating the photooutput decrease is further injection of current into the active layer. However, this causes, on the other hand, the active layer temperature, i.e., the element temperature increase, causing the opposite effect of shifting the oscillation [[wave]] wavelength to a longer wavelength. Resultantly, the wavelength variation width is decreased. Furthermore, the wavelength shift due to the temperature increase must be again controlled by the wavelength tuning current, which complicates the wavelength variation method.

Please amend the paragraph on page 7, beginning at line 15 as follows:

The TTG-LD includes, as described above, 2 layers, the MQW active layer for current to be injected into from the electrode formed on the upper surface of the substrate and the wavelength ~~control~~ tuning layer for current to be injected into from the electrode formed on the underside of the substrate. Accordingly, when the TTG-LD is integrated with other elements, such as an optical waveguide, etc., on one and the same substrate, disadvantages, such as characteristic deterioration,

etc., will take place.

Please amend the paragraph on page 8, beginning at line 19 as follows:

According to one aspect of the present invention, there is provided a photosemiconductor device comprising: a light oscillation part formed in a first region of a first conduction-type semiconductor substrate and including a first active layer which generates light by current injection, a wavelength tuning layer with a second conduction-type intermediate layer formed between the first active layer and the wavelength tuning layer, for varying an oscillation wavelength by current injection, and a diffraction grating formed near the first active layer and the wavelength tuning layer; and a light amplification part formed in a second region of the semiconductor substrate and including a second active layer which amplifies light by current injection, for amplifying light generated by the light oscillation part.

Please amend the paragraph on page 9, beginning at line 9 as follows:

According to another aspect of the present invention, there is provided a photosemiconductor device comprising: a light oscillation part formed in a first region of a first conduction-type semiconductor substrate and including an active layer, for generating light by current injection, and a wavelength ~~control~~ tuning layer with a second-conduction type intermediate layer formed between the active layer and the wavelength ~~control~~ tuning layer, for varying an oscillation wavelength of the active layer by current injection; and an optical waveguide part including an insulation film [[layer]]

formed in a second region of the semiconductor substrate and an optical waveguide layer formed above the insulation film, for guiding light output from the light oscillation part.

Please amend the paragraph on page 9, beginning at line 23 as follows:

According to further another aspect of the present invention, there is provided a method for fabricating a photosemiconductor device comprising the steps of: forming in a first region of a first conduction-type semiconductor substrate an active layer for generating light by current injection, and a wavelength ~~control~~ tuning layer with a second conduction-type intermediate layer formed between the active layer and the wavelength ~~control~~ tuning layer, for changing an oscillation wavelength of the active layer by current injection; forming an insulation film [[layer]] in a second region of the semiconductor substrate; forming an optical waveguide layer on the insulation film [[layer]]; patterning the active layer, the intermediate layer and the wavelength ~~control~~ tuning layer to form a first mesa stripe in the first region, and patterning the insulation film and the optical waveguide layer to form a second mesa stripe in the second region; and forming a buried layer electrically connected to the intermediate layer, for covering the side surface of the first mesa stripe and the side surface of the second mesa stripe.

Please amend the paragraph on page 10, beginning at line 18 as follows:

According to further another aspect of the present invention, there is provided a photosemiconductor device comprising: a light oscillation part formed on a first conduction-type

semiconductor substrate and including a plurality of light oscillation elements which include an active layer for generating light by current injection, a wavelength tuning layer with a second conduction-type intermediate layer formed between the active layer and the wavelength tuning layer, for varying an oscillation wavelength by current injection, and a diffraction grating formed near the active layer and the wavelength tuning layer; and a current leading-out part for selectively leading out current injected into the active layer or the wavelength tuning layer from the intermediate layer of an arbitrary one of the light oscillation elements.

Please amend the paragraph on page 11, beginning at line 7 as follows:

According to further another aspect of the present invention, there is provided a method for driving a photosemiconductor device comprising a plurality of light oscillation elements formed on a first conduction-type semiconductor substrate and including an active layer for generating light by current injection, a wavelength tuning layer with a second conduction-type intermediate layer formed between the active layer and the wavelength tuning layer, for varying oscillation wavelengths by current injection, and a diffraction grating formed near the active layer and the wavelength tuning layer, the method comprising the step of injecting current into the active layer or the wavelength tuning layer of the plurality of the light oscillation elements with the intermediate layer of one selected out of the light oscillation elements connected to a reference potential and with the intermediate layer of the other light oscillation elements floated.

Please amend the paragraph on page 11, beginning at line 24 as follows:

According to further another aspect of the present invention, there is provided a method for driving a photosemiconductor device comprising: a light oscillation part formed on a first conduction-type semiconductor substrate and including a plurality of light oscillation elements including an active layer for generating light by current injection, a wavelength tuning layer with a second conduction-type intermediate layer formed between the active layer and the wavelength tuning layer, for varying oscillation wavelengths by current injection, a diffraction grating formed near the active layer and the wavelength tuning layer; a first current injecting part for injecting current into the active layer or the wavelength tuning layer of the plurality of the light oscillation elements via an electrode formed on the side of a first surface of the semiconductor substrate; a second current injecting part for injecting current into the wavelength tuning layer or the active layer of the plurality of the light oscillation elements via an electrode formed on the side of a second surface of the semiconductor substrate; a current leading-out part including a plurality of wires connecting the intermediate layer of the respective plurality of the light oscillation elements to a reference potential and a plurality of switches provided in the respective plurality of the wires, the method comprising the step of injecting current by the first current injecting part and the second current injecting part with one of the plurality of the switches being closed and with the other switches opened.

Please amend the paragraph on page 13, beginning on line 1 as follows:

According to further another aspect of the present invention, there is provided a method for driving a photosemiconductor device comprising: a light oscillation part formed on a first conduction-type semiconductor substrate and including a plurality of light oscillation elements including an active layer for generating light by current injection, a wavelength tuning layer with a second conduction-type intermediate layer formed between the active layer and the wavelength tuning layer, for varying an oscillation wavelength by current injection, and a diffraction grating formed near the active layer and the wavelength tuning layer; a first current injecting part including a first electric power source, a plurality of first wires connecting the active layer or the wavelength tuning layer of the plurality of the light oscillation elements in parallel to the first electric power source and a plurality of first switches respectively provided in the plurality of the first wires, for injecting current into the active layer or the wavelength tuning layer of an arbitrary one of the light oscillation elements via an electrode formed on the side of a first upper surface of the semiconductor substrate; a second current injecting part including a second electric power source, for injecting current into the wavelength tuning layer or the active layer of the plurality of light oscillation elements via an electrode formed on the side of a second surface of the semiconductor substrate; and a current leading-out part including a plurality of second wires connecting the intermediate layer of the respective plurality of the light oscillation elements to a reference potential and a plurality of second switches provided respectively in the plurality of the second wires, the method comprising the step of driving the first electric power source and the second electric power source to drive one

of the plurality of light oscillation elements with the first switch and the second switch provided in the first wire and the second wire connected to one of the plurality of the light oscillation elements closed and with the other first switches and the second switches provided in the first wires and the second wires connected to the other light oscillation elements opened.

Please amend the paragraph on page 14, beginning at line 21 as follows:

According to the present invention, a light oscillation part formed in a first region of a first conduction-type semiconductor substrate and including an active layer and a wavelength ~~control~~ tuning layer formed with a second conduction-type intermediate layer between the active layer and the wavelength ~~control~~ tuning layer, for varying an oscillation wavelength of the active layer by current injection is provided, and an optical waveguide part including an insulation film formed in a second region of the semiconductor device and an optical waveguide layer formed above the insulation film, for guiding light output from the light oscillation part are provided. Accordingly, the TTG-LD and the optical waveguide part can be integrated on one and the same substrate without characteristic deterioration.

Please amend the paragraph on page 15, beginning at line 10 as follows:

According to the present invention, a light oscillation part formed on a first conduction-type semiconductor substrate and including a plurality of light oscillation elements including an active layer for generating light by current injection, a wavelength tuning layer with a second conduction-

type intermediate layer formed between the active layer and the wavelength tuning layer, for varying oscillation wavelengths by current injection, and a diffraction grating formed near the active layer and the wavelength tuning layer is provided, and a current leading-out part for leading out current injected into the active layer or the wavelength tuning layer selectively from the intermediate layer of an arbitrary one of the plurality of the light oscillation elements is provided. Accordingly, the light oscillation elements can be driven independently of one another, and photooutputs of wavelength variation ranges which are wider than those provided by using one light oscillation element can be realized.

Please amend the paragraph on page 22, beginning on the last line and continuing to page 24 as follows:

The TTG laser part has the sectional structure shown in FIG. 1B. On the semiconductor substrate 10 of p type InP there are formed a p type InP layer 12, a lower clad layer 14 of p type InP, an MQW (Multiple Quantum Well) active layer 20, an intermediate layer 22 of an n type InP layer, a wavelength tuning layer 24 of an InGaAsP layer, a clad layer 25 of a p type InP layer, an InGaAsP layer 26 with a diffraction grating 28 formed in and a buried layer 30 of an InP layer. The buried layer 30, the InGaAsP layer 26, the wavelength tuning layer 24, the intermediate layer 22, the MQW active layer 20 and the lower clad layer 14 are patterned in a mesa, forming a mesa stripe. A buried layer 38 of an n type InP layer is formed on both sides of the mesa stripe. A p type InP layer 40 is formed on the buried layers 30, 38. An electrode 46 of Au/Zn is formed on the p type InP layer 40

with a contact layer 42 of a p type InGaAs layer formed therebetween. An electrode 50 of Au/Ge is formed on the buried layer 38. An electrode 54 of Au/Zn is formed on a second surface with no element formed on, i.e. the underside of the semiconductor substrate 10. A protection film 44 of silicon oxide film is formed on the exposed surfaces of the p type InP layers 12, 40 and the buried layer 38. In this specification, the first surface of the semiconductor substrate means the upper surface of the semiconductor substrate with the element formed on, and the second surface of the semiconductor device means underside of the semiconductor device with no element formed on.

Please amend the paragraph on page 25, beginning at line 15 as follows:

Simultaneously therewith, a prescribed voltage is applied between the electrode 46 and the electrode 50 to inject current from the electrode 46. The current injected from the electrode 46 is injected into the <u>wavelength</u> tuning layer 24 via the p type InP layer 40, the buried layer 30 and the InGaAsP layer 26 to be led out from the electrode 50 via the intermediate layer 22 and the buried layer 38. The current is injected into the <u>wavelength</u> tuning layer 24 to thereby decrease the refractive index by the plasma effect and decrease the effective refractive index of the optical waveguide layer. Resultantly the DFB oscillation wavelength is shortened. Thus, the DFB oscillation wavelength can be controlled by the current injected into the <u>wavelength</u> tuning layer 24.

Please amend the paragraph on page 28, beginning at line 19 as follows:

Then, on the MQW layer 20, an n type InP layer, e.g. of a 160 nm-thickness and a 1×10^{18} cm^{-3}

dopant dose, and an InGaAsP layer, e.g. of a 290 nm-thickness and a 1.3 μm-composition are formed by, e.g., MOCVD. Thus, on the MQW active layer 20, the intermediate layer 22 of the n type InP layer, and the wavelength tuning layer 24 of the InGaAsP layer are formed (FIG. 2C).

Please amend the paragraph on page 28, beginning at line 26 as follows:

Then, on the wavelength tuning layer 24, the clad layer 25, e.g. of a 10 nm-thickness and a 1×10^{18} cm^{-3} dopant dose, and the InGaAsP layer 26 of a 200 nm-thickness and a 1.15 μm-composition are formed.

Please amend the paragraph on page 29, beginning at line 16 as follows:

Then, with the silicon oxide film 32 as a mask, the buried layer 30, the InGaAsP layer 26, the wavelength tuning layer 24 and the intermediate layer 22 are etched to remove the buried layer 30, the InGaAsP layer 26, the wavelength tuning layer 24 and the intermediate layer 22 in the SOA part (FIG. 3A).

Please amend the paragraph on page 29, beginning at line 22 as follows:

The wavelength tuning layer 24 and the intermediate layer 22 in the SOA part may not be essentially removed. The composition of the wavelength tuning layer 24 is ~~liker~~ more similar to that of the active layer than that of the clad layer, and the wavelength tuning layer 24 is somewhat photo-absorptive. Accordingly, leaving the wavelength tuning layer 24 in the SOA part makes the light loss

large. However, the wavelength tuning layer 24 acts to confine light, as does the active layer. In the case that the optical waveguide is bent in the SOA part, the wavelength tuning layer 24 acts to decrease the bend loss. Preferably, whether or not the wavelength tuning layer 24 is left in the SOA part is suitably determined depending on the trade between the photo-absorption and the bend loss.

Please amend the paragraph on page 30, beginning at line 24 as follows:

Then, with the silicon oxide film 36 as a mask, the buried layer 30, the InGaAsP layer 26, the wavelength tuning layer 24, the intermediate layer 22, the MQW active layer 20, the lower clad layer 14 in the TTG laser part, and the upper clad layer 34, the MQW active layer 20 and the lower clad layer 18 in the SOA part are anisotropically etched to form the mesa stripe of, e.g., a 1.0 μm-width (refer to FIGS. 1B and 1C).

Please amend the paragraph on page 34, beginning at line 19 as follows:

That is, the TTG laser part has the sectional structure shown in FIG. 4B. On a semiconductor substrate 10 of p type InP there are formed a p type InP layer 12, an InGaAsP layer 26 with a diffraction grating 28 formed in, a buried layer 30 of an InGaAsP layer, a wavelength tuning layer 24 of an InGaAsP layer, an intermediate layer 22 of an n type InP layer and an MQW active layer 20. The MQW active layer 20, the intermediate layer 22, the wavelength tuning layer 24, the buried layer 30 and the InGaAsP layer 26 are patterned in a mesa, forming a mesa stripe. A buried layer 38 of an n type InP layer 38 is formed on both sides of the mesa stripe. A p type InP layer 40 is formed

on the MQW active layer 20 and the buried layer 38. On the p type InP layer 40, an electrode 46 of Au/Zn is formed with the contact layer 42 of a p type InGaAs layer formed therebetween. On the buried layer 38, an electrode 50 of Au/Ge is formed. On the underside of the semiconductor substrate 10, an electrode 54 of Au/Zn is formed. A protection film 44 of silicon oxide film is formed on the exposed surfaces of the p type InP layers 12, 40 and the buried layer 38.

Please amend the paragraph on page 36, beginning at line 6 as follows:

Simultaneously therewith, a prescribed voltage is applied between the electrode 46 and the electrode 50 to inject current from the electrode 46. The current injected from the electrode 46 is injected into the wavelength tuning layer 24 via the p type InP layer 12, the buried layer 30 and the InGaAsP layer 26 to be led out from the electrode 50 via the intermediate layer 22 and the buried layer 38. The current is injected into the wavelength tuning layer 24 to thereby decrease the refractive index by the plasma effect and decrease the effective refractive index of the optical waveguide layer. Resultantly the DFB oscillation wavelength is shortened. Thus, the DFB oscillation wavelength can be controlled by the current injected into the wavelength tuning layer 24.

Please amend the paragraph on page 37, beginning at line 13 as follows:

Then, on the buried layer 30, an InGaAsP layer, e.g. of a 290 nm-thickness and a 1.3 μm-composition and an n type InP layer, e.g. of a 160 nm-thickness and a 1×10^{18} cm^{-3} dopant dose are formed. Thus, the wavelength tuning layer 24 of the InGaAsP layer and the intermediate layer 22 of

the n type InP layer are formed on the buried layer 30 (FIG. 5B).

Please amend the paragraph on page 37, beginning at line 24 as follows:

Next, with the silicon oxide film 32 as a mask, the intermediate layer 22, the wavelength tuning layer 24, the buried layer 30 and the InGaAsP layer 26 are etched to remove the intermediate layer 22, the wavelength tuning layer 24, the buried layer 30 and the InGaAsP layer 26 in the SOA part (FIG. 5C).

Please amend the paragraph on page 38, beginning at line 25 as follows:

Next, with the silicon oxide film 36 as a mask, the p type InP layer 21, the MQW active layer 20, the intermediate layer 22, the wavelength tuning layer 24, the buried layer 30 and the InGaAsP layer 26 in the TTG laser part, and the p type InP layer 21, the MQW active layer 20 and the lower clad layer 18 in the SOA part are anisotropically etched to form the mesa stripe of, e.g., a 1.0 μm-width (refer to FIGS. 4B and 4C).

Please amend the paragraph on page 55, beginning at line 22 as follows:

First, on the semiconductor substrate, a layer structure including a wavelength ~~control~~ tuning layer, an intermediate layer and an active layer of TTG-LD is formed.

Please amend the paragraph on page 55, beginning at line 26 as follows:

Then, a mask is formed in the region except the region for the optical waveguides and the optical coupler to be formed in, and then the layer structure including the wavelength ~~control~~ tuning layer, the intermediate layer and the active layer in the region for the optical waveguides and the optical coupler to be formed in is etched off.

Please amend the paragraph on page 58, beginning at line 18 as follows:

With the optical waveguide part of the structure shown in FIG. 13, when current for the wavelength control is injected into the wavelength ~~control~~ tuning layer of the TTG-LDs from the lower electrode formed on the second surface with no element formed on, i.e. the underside of the substrate of the TTG-LD array part, the current for the wavelength control flows also in the following route because the n type InP buried layer 140 is connected to the earth potential. That is, the current for the wavelength control flows through the lower clad layer 130 and the core layer 132 of the optical waveguide part, then through the n type InP buried layer 140 on both sides of the core layer 132 and to the outside earth potential. This means the current injection into the wavelength ~~control~~ tuning layer is less effective.

Please amend the paragraph on page 59, beginning at line 7 as follows:

In the case that the TTG-LD and the optical waveguide are integrated on one and the same substrate and both stripe structures are buried in one and the same buried layer, such a case of

arraying the TTG-LDs as described above, it is conceivable that the efficiency of the current injection into the wavelength ~~control~~ tuning layer of the TTG-LDs is lowered, which will lead to the occurrence of malfunction in which efficiency of the wavelength conversion for the injected current is lowered ~~lowerd~~.

Please amend the paragraph on page 59, beginning at line 16 as follows:

The photosemiconductor device and the method for fabricating the photosemiconductor device according to a ninth to an eleventh embodiments of the present invention which will be described in detail below can realize the suppression of the decrease of the efficiency of the current injection into the wavelength ~~control~~ tuning layer of the TTG-LD and realize the increase of the efficiency of the wavelength conversion for the injected current.

Please amend the paragraph on page 61, beginning at line 13 as follows:

On the buffer layer 150, a quaternary diffraction grating layer 154 with a diffraction grating formed in, a spacer layer 156 of p type InP,, a wavelength tuning layer, i.e., a wavelength ~~control~~ tuning layer 158 of non-doped InGaAsP, an intermediate layer 160 of n type InP, an MQW active layer 162 of InGaAsP, and a clad layer 164 of p type InP are laid sequentially the latter on the former. These layers, and an upper part of the semiconductor substrate 144, are etched to form a mesa stripe. The buffer layer 150 may be made thick enough to hinder the mesa stripe to be etched down to the semiconductor substrate 144.

Please amend the paragraph on page 65, beginning at line 13 as follows:

Simultaneously therewith, a prescribed voltage is applied between the p type electrode 152 on the second surface with no element formed on, i.e. the underside of the semiconductor substrate 144 and the n type electrode (not shown) electrically connected to the n type InP buried layer 170 to inject current from the p type electrode 152. The current injected from the p type electrode 152 is injected into the wavelength ~~control~~ <u>tuning</u> layer 158 via the semiconductor substrate 144, the buffer layer 150, the quaternary diffraction grating layer 154 and the spacer layer 156 to be led out from the n type electrode via the intermediate layer 160 and the n type InP buried layer 170. The current is injected into the wavelength ~~control~~ <u>tuning</u> layer 158, whereby the refractive index is decreased due to the plasma effect, and the effective refractive index of the optical waveguide layer is decreased. This shortens the oscillation wavelength. Accordingly, the oscillation wavelength of the TTG-LD can be controlled by the current injected in the wavelength ~~control~~ <u>tuning</u> layer 158.

Please amend the paragraph on page 66, beginning at line 7 as follows:

As described above, in the optical waveguide part 148, the rectifying layer 180 is formed of the n type InP layer 176 and the p type InP layer 178 laid the latter on the former between the semiconductor substrate 144 and the optical waveguide 187. The buried layers burying the mesa stripe of the optical waveguide part 148 is the rectification structure formed of the n type InP buried layer 166, the p type InP buried layer 168 and the n type InP buried layer 170 laid the latter on the former. Thus, the rectifying layer 180 and the buried layers which have rectification structure

insulate the optical waveguide 187 from the semiconductor substrate 144. Thus, when current is injected into the wavelength ~~control~~ tuning layer 158, the generation of leak current which flows from the semiconductor substrate 144 to the optical waveguide 187 and flows to the earth potential through the n type InP buried layer 170 on both sides of the optical waveguide 187 can be suppressed. Accordingly, upon the oscillation wavelength control of the TTG-LD 175, current can be injected very effectively into the wavelength ~~control~~ tuning layer 158, and the wavelength conversion efficiency for the injected current can be improved.

Please amend the paragraph on page 68, beginning at line 10 as follows:

Then, on the spacer layer 156, the wavelength ~~control~~ tuning layer 158 of non-doped InGaAsP of, e.g., a 0.3 μm-thickness and λ_{PL}=1.3 μm is formed by, e.g., MOCVD.

Please amend the paragraph on page 68, beginning at line 13 as follows:

Then, on the wavelength ~~control~~ tuning layer 158, the intermediate layer 160 of n type InP of, e.g., a 0.15 μm-thickness is formed by, e.g., MOCVD.

Please amend the paragraph on page 69, beginning at line 11 as follows:

Next, with the silicon oxide film 188 as a mask, the clad layer 164, the MQW active layer 162, the intermediate layer 160, the wavelength ~~control~~ tuning layer 158, the spacer layer 156, the quaternary diffraction grating layer 154, the buffer layer 150 and the upper part of the semiconductor

substrate 144 are etched into a 2.5 μm-depth (refer to FIG. 17B).

Please amend the paragraph on page 70, beginning at line 11 as follows:

Then, with the silicon oxide film 190 as a mask, the clad layer 164, the MQW active layer 162, the intermediate layer 160, the wavelength ~~control~~ tuning layer 158, spacer layer 156, the quaternary diffraction grating layer 154, the buffer layer 150, the upper part of the semiconductor substrate 144 in the TTG-LD part 146, the upper clad layer 186, the core layer 184, the lower clad layer 182, the p type InP layer 178 and the n type InP layer 176 in the optical waveguide part 148 are respectively anisotropically etched in a 2.5 μm-depth to form the mesa stripe of, e.g., a 1.0 μm-width. Thus, the mesa stripe of the TTG-LD part 146 and the mesa stripe of the optical waveguide part 148 are formed continuous to each other (refer to FIG. 19A).

Please amend the paragraph on page 74, beginning at line 23 as follows:

As described above, according to the present embodiment, when the TTG-LD 175 and the optical waveguide 187 are integrated on one and the same semiconductor substrate 144, the rectifying layer 180 of the n type InP layer 176 and the p type InP layer 178 laid the former on the later is formed below the optical waveguide 187 including the lower clad layer 182, the core layer 184 and the upper clad layer 186, whereby the semiconductor substrate 144 and the optical waveguide 187 are insulated from each other, and the generation of leak current between the two can be suppressed. Resultantly, upon the oscillation wavelength control of the TTG-LD, current can be

every effectively injected into the wavelength ~~control~~ tuning layer 158, and the wavelength conversion effectiveness for the injected current can be improved. Accordingly, the TTG-LD 175 and the optical waveguide 187 can be integrated on one and the same substrate without characteristic deterioration.

Please amend the paragraph on page 76, beginning on the last line and continuing to page 77 as follows:

As described above, in the optical waveguide part 148 of the photosemiconductor device according to the present embodiment, the semi-insulating semiconductor layer 212 of semi-insulating InP is formed between the semiconductor substrate 144 and the core layer 184, whereby, together with the rectification structure of the buried layers burying the mesa stripe of the optical waveguide part 148, the semiconductor substrate 144 and the optical waveguide 187 are insulated from each other. Thus, when current is injected from the p type electrode 152 into the wavelength ~~control~~ tuning layer 158 to control the oscillation wavelength of the TTG-LD 175, the generation of leak current which flows from the semiconductor substrate 144 to the optical waveguide 187 and flows to the earth potential through the n type InP buried layer 170 on both sides of the optical waveguide 187 can be suppressed in the same way as in the photosemiconductor device according to the ninth embodiment. Accordingly, upon the oscillation wavelength control of the TTG-LD 175, current can be injected very effectively into the wavelength ~~control~~ tuning layer 158, and the wavelength conversion efficiency for the injected current can be improved.

Please amend the paragraph on page 79, beginning at line 25 as follows:

As shown in FIG. 26, the SOA part 216 has substantially the same sectional structure as that of the TTG-LD 175. That is, on the semiconductor substrate 144, a mesa stripe is formed by laying sequentially the former on the latter and etching a buffer layer 150 of p type InP, a wavelength ~~control~~ <u>tuning</u> layer 158 of non-doped InGaAsP, an intermediate layer 160 of n type InP, an MQW active layer 162 of InGaAsP and a clad layer 164 of p type InP. On the semiconductor substrate 144 of the mesa stripe, an n type InP buried layer 166, a p type InP buried layer 168 and an n type InP buried layer 170 are sequentially formed, burying the mesa stripe. A cap layer 172 is formed on the n type InP buried layer 170 and the clad layer 164 of the mesa stripes. On the cap layer 172, a p type electrode 222 electrically connected to the MQW active layer 162 via the cap layer 172 and the clad layer 164 for injecting current into the MQW active layer 162 are formed. On the n type InP buried layer 170, an n type electrode (not shown) is formed, electrically connected to the intermediate layer 160 via the n type InP buried layer 170. Thus, the SOA 220 is formed in the SOA part 216. The layer structure of the SOA part 216, which is substantially the same as that of the TTG-LD array part 214 can be formed concurrently with forming the layer structure of the TTG-LD array part 214. An InGaAsP layer (not shown) which corresponds to the quaternary diffraction grating layer of the TTG-LD 175 is formed in the SOA part 216 but has no diffraction grating formed in. In the operation of the photosemiconductor device, a prescribed voltage is applied between the p type electrode 222 and the n type electrode formed on the n type InP buried layer 170 to inject current into the MQW active layer 162, whereby the photo-amplification is performed.

Please amend the paragraph on page 81, beginning at line 17 as follows:

Furthermore, the photosemiconductor device according to the present embodiment is characterized mainly in that, as in the photosemiconductor device according to the ninth embodiment, the rectifying layer 180 formed by laying the n type InP layer 176 and the p type InP layer 178 the latter on the former is provided below the lower clad layer 182, the core layer 184 and the upper clad layer 186 of the optical waveguide part 148. Accordingly, the generation of the leak current which, when current is injected into the wavelength ~~control~~ <u>tuning</u> layer 158 of the array of the TTG-LDs 175 from the p type electrode 152 on the underside of the semiconductor substrate 144, flows from the semiconductor substrate 144 and through the optical waveguides 187 and the n type InP buried layer 170 on both sides of the optical waveguides 187 can be suppressed. Thus, the decrease of the current injection efficiency of the wavelength ~~control~~ <u>tuning</u> layer 158 of the TTG-LD 175 can be suppressed, and the increase of the wavelength conversion effectiveness for the injected current can be realized.

Please amend the paragraph on page 82, beginning at line 11 as follows:

As described above, according to the present embodiment, a plurality of TTG-LDs 175 having central oscillation wavelengths different from each other, and the SOA 220 are integrated on the semiconductor substrate 144, whereby wide wavelength variation ranges can be realized without decreasing the photooutput. Because of the rectifying layer 180 formed between the semiconductor substrate 144 and the optical waveguide 187 of the optical waveguide part 148, the decrease of the

effectiveness of the current injection into the wavelength ~~control~~ tuning layer 158 of the TTG-LD 175 can be suppressed, and furthermore, the increase of the wavelength conversion effectiveness for the injected current can be realized.

Please amend the paragraph on page 84, beginning at line 11 as follows:

The TTG laser part has the sectional structure as shown in FIG. 27B. On the semiconductor substrate 310 of p type InP, there are formed a p type InP layer 312, a lower clad layer 314 of p type InP, MQW (Multiple Quantum Well) active layer 320, an intermediate layer 322 of an n type InP layer, a wavelength tuning layer 324 of an InGaAsP layer, a clad layer 325 of a p type InP layer, an InGaAsP layer 326 with a diffraction grating 328 formed in, and a buried layer 330 of an InP layer. The buried layer 330, the InGaAsP layer 326, the wavelength tuning layer 324, the intermediate layer 322, the MQW active layer 320 and the lower clad layer 314 are patterned in a mesa, forming a mesa stripe. A buried layer 338 of an n type InP layer is formed on both sides of the mesa stripe. On the buried layers 330, 338, a p type InP layer 340 is formed. On the p type InP layer 340, an electrode 346 is formed with a contact layer 342 of a p type InGaAs layer formed therebetween. An electrode 350 is formed on the buried layer 338. An electrode 354 is formed on the second surface with no element formed on, i.e. the underside of the semiconductor substrate 310. A protection film 344 of a silicon oxide film is formed on the exposed surfaces of the p type InP layers 312, 340 and the buried layer 338. In this specification, the first surface of the semiconductor substrate means the upper surface of the semiconductor substrate with the element formed on, and the second surface of

the semiconductor device means underside of the semiconductor device with no element formed on.

Please amend the paragraph on page 87, beginning at line 12 as follows:

Simultaneously therewith, with the first switch 362 closed, a prescribed voltage is applied between the electrode 346 and the electrode 350 from the wavelength control electric power source 360 to inject current from the electrode 346. The current injected from the electrode 346 is injected into the <u>wavelength</u> tuning layer 324 via the p type InP layer 340, the buried layer 330 and the InGaAsP layer 326 and is led out from the electrode 350 via the intermediate layer 322 and the buried layer 338. Current is injected into the <u>wavelength</u> tuning layer 324, whereby the refractive index is decreased by the plasma effect, and the effective refractive index of the optical waveguide layer is decreased. Accordingly, the DFB oscillation wavelength is shortened. Thus, the DFB oscillation wavelength can be controlled by the current injected into the <u>wavelength</u> tuning layer 324.

Please amend the paragraph on page 91, beginning at line 16 as follows:

Another means which can electrically isolate the arrayed TTG-DFB lasers will arraying the TTG-DFB lasers on a semi-insulating semiconductor substrate. However, in the case that a semi-insulating semiconductor substrate is used, electrodes electrically connected to the active layers, electrodes electrically connected to the <u>wavelength</u> tuning layers and electrodes electrically connected to the intermediate layer must be arranged on the side of the upper surface of the substrate. Because of this arrangement of the electrodes, the wiring pattern must be designed to be a multi-level

interconnection, which results in an increased number of the electrode forming steps, further in a increased number of the electrode pads, and larger element dimensions.

Please amend the paragraph on page 97, beginning at line 5 as follows:

In the region where the respective TTG-DFB lasers 408a, 408b, 408c are formed, on the semiconductor substrate 400 there are formed a p type InP layer 416, e.g. of a 2000 nm-thickness and a $1x10^{18}$ m^{-3} dopant dose, a lower clad layer 418 of a p type InP layer, e.g. of a $1x10^{18}$ m^{-3} dopant dose, an MQW active layer 420, an intermediate layer 422 of an n type InP layer, e.g., of a 160 nm-thickness and a $1x10^{18}$ m^{-3} dopant dose, a <u>wavelength</u> tuning layer 424 of an InGaAsP layer of, e.g., a 290 nm-thickness and a 1.3 μm-composition, an InGaAsP layer 426, e.g., of a 290 nm-thickness and a 1.3 μm-composition with a diffraction grating formed in, and a buried layer 428 of a InP layer of, e.g., a 100 nm-thickness.

Please amend the paragraph on page 98, beginning at line 5 as follows:

The buried layer 428, the InGaAsP layer 426, the <u>wavelength</u> tuning layer 424, the intermediate layer 422, the MQW active layer 420 and the lower clad layer 418 are patterned in a mesa, forming a mesa stripe with the active layer set in, e.g., a 1.0 μm-width.

Please amend the paragraph on page 103, beginning at line 24 as follows:

Next, the method for driving the photosemiconductor device according to the present

embodiment will be explained with reference to FIGS. 33A-33B, 34A-34B, 35A-35C and 36A-36B. In this description, the TTG-DFB lasers 408a, 408b, 408c on the left side, at the center and the right side of FIG. 33A oscillate respective signal light CH1, CH2, CH3. In the circuit diagrams of FIGS. 35A-35C and 36A-36B, the MQW active layers 420 and the wavelength tuning layers 424 of the TTG-DFB lasers 408a, 408b, 408c are represented by marks indicative diodes.

Please amend the paragraph on page 104, beginning at line 21 as follows:

In the TTG-DFB laser 408a of CH1, the drive change-over switch 472a is closed. Accordingly, the intermediate layer 422 of the TTG-DFB laser 408a is grounded, and current is injected into the MQW active layer 420 and the wavelength tuning layer 434. Thus, the TTG-DFB 408a of CH1 is in the driven state.

Please amend the paragraph on page 105, beginning at line 1 as follows:

On the other hand, in the TTG-DFB laser 408b of CH2 and the TTG-DFB laser 408c of CH3, the drive change-over switches 472b, 472c are opened. Accordingly, the intermediate layer 422 of the TTG-DFB lasers 408b, 408c is not grounded and is floating, and no current is injected into the MQW active layer 420 and the wavelength tuning layer 434. Thus, the TTG-DFB lasers 408b, 408c of CH2 and CH3 are not driven.

Please amend the paragraph on page 105, beginning at line 15 as follows:

First, the drive of the wavelength control electric power source 464 and the laser drive electric power source 468 is stopped in the state of FIG. 35A, and the generation of the source voltage in the wavelength control electric power source 464 and the laser drive electric power source 468 is stopped (refer to FIG. 35B). Thus, the injection of current into the <u>wavelength</u> tuning layer 424 and the MQW active layer 420 of the TTG-DFB laser 408a of CH1 is stopped.

Please amend the paragraph on page 106, beginning at line 6 as follows:

Next, the drive of the wavelength control electric power source 464 and the laser drive electric power source 468 are resumed to generate a prescribed source voltage in the wavelength control electric power source 464 and in the laser drive electric power source 468 (refer to FIG. 36B). Current is injected into the <u>wavelength</u> tuning layer 424 and the MQW active layer 420 of the TTG-DFB laser 408b of CH2, and the current is led out from the intermediate layer 422. Thus, the TTG-DFB laser 408b of CH2 is driven and is placed in the steady state having a prescribed oscillation wavelength. The current amount to be injected into the <u>wavelength</u> tuning layer 424 from the wavelength control electric power source 464 is adjusted, whereby the oscillation wavelength of the TTG-DFB laser 408b CH2 can be controlled.

Please amend the paragraph on page 106, beginning at line 21 as follows:

On the other hand, in the TTG-DFB lasers 408a, 408c of CH1 and CH3, the drive change-

over switches 472a, 472c are set opened. Accordingly, the intermediate layer 422 of the TTG-DFB lasers 408a, 408c are not grounded and in the floating state. No current is injected into the MQW active layer 420 and the wavelength tuning layer 424. Thus, the TTG-DFB lasers 408a, 408c of CH1 and CH3 are not driven.

Please amend the paragraph on page 109, beginning at line 7 as follows:

In the photosemiconductor device according to the twelfth embodiment, no switches are provided in the wires 462, 462a, 462b, 462c interconnecting the wavelength control electric power source 464 and electrodes 436 of the respective TTG-DFB lasers 408a, 408b, 408c which are arrayed. Accordingly, when the photosemiconductor device is in operation, current is injected into the wavelength tuning layer 424 of the TTG-DFB lasers which are not driven. Resultantly, reactive power is generated due to leak current, etc. in the TTG-DFB lasers which are not driven. Cases that stable laser oscillation at a single wavelength is difficult might take place.

Please amend the paragraph on page 110, beginning at line 23 as follows:

FIG. 38A shows the state of the driving circuit where the TTG-DFB laser 408a of CH1 is driven and is in the steady state having a prescribed oscillation wavelength. The state of the drive change-over switches at this time is that the drive change-over switch 472a is closed, and the drive change-over switches 472b, 472c are opened. The state of the current injection switches is that the current injection switch 476a is closed, and the current injection switches 476b, 476c are opened.

The wavelength control electric power source 464 and the laser drive electric power source 468 are driven, and as in the twelfth embodiment, current is injected into the MQW active layer 420 and the wavelength tuning layer 424 alone of the TTG-DFB laser 408a of CH1.

Please amend the paragraph on page 111, beginning at line 18 as follows:

Then, the drive change-over switch 472a and the current injection switch 476a of the TTG-DFB laser 408a of CH1 are opened, and all the drive change-over switches 472a, 472b, 472c and the current injection switches 476a, 476b, 476c of the TTG-DFB lasers of CH1-CH3 are opened (refer to FIG. 38C). Here, the drive change-over switch 472a and the current injection switch 476a are opened after the drive of the wavelength control electric power 464 is stopped, so that the breakage of the TTG-DFB laser due to the sudden stop of the current injection into the wavelength tuning layer 424 is prevented.

Please amend the paragraph on page 112, beginning at line 9 as follows:

Then, the drive of the wavelength control electric power source 464 and the laser drive electric power source 468 are resumed (refer to FIG. 39B). Thus, as in the twelfth embodiment, current is injected into the wavelength tuning layer 424 and the MQW active layer 420 of the TTG-DFB laser 408b of CH2 alone, and the TTG-DFB laser 408b of CH2 alone is driven. Here, the drive change-over switch 472b and the current injection switch 476b are closed before the drive of the wavelength control electric power source 464 is resumed, so that the breakage of the TTG-DFB laser

due to the sudden start of the current injection into the wavelength tuning layer 424 is prevented.

Please amend the paragraph on page 115, beginning at line 2 as follows:

That is, the laser array part 402 has the sectional structure shown in FIGS. 40A and 40B. In the region where the TTG-DFB lasers 408a, 408b, 408c are formed, on a semiconductor substrate 400 of p type InP there are formed a p type InP layer 416, an InGaAsP layer 426 with a diffraction grating formed in, a buried layer 428 of an InGaAsP layer, a wavelength tuning layer 424 of an InGaAsP layer, an intermediate layer 422 of an n type InP layer and an MQW active layer 420. The MQW active layer 420, the intermediate layer 422, the wavelength tuning layer 424, the buried layer 428 and the InGaAsP layer 426 are patterned in a mesa, forming a mesa stripe. A buried layer 430 of an n type InP layer is formed on both sides of the mesa stripe. A p type InP layer 432 is formed on the MQW active layer 420 and the buried layer 430. On the p type InP layer 432, an electrode 436 of Au/Zn is formed with a contact layer 434 of a p type InGaAs layer formed therebetween. On the buried layer 430, an electrode 438 of Au/Ge is formed. An electrode 444 of Au/Zn is formed on the second surface with no element formed on, i.e. the underside of the semiconductor substrate 400. A protection film 442 of a silicon oxide film is formed on the exposed surfaces of the p type InP layers 416, 432 and the buried layer 430.

Please amend the paragraph on page 118, beginning at line 14 as follows:

In the ninth to the eleventh embodiments, the rectifying layer 180 or the semi-insulating

semiconductor layer 212 are formed between the semiconductor substrate 144, and the optical waveguide structure including the lower clad layer 182, the core layer 184 and the upper clad layer 186. However, any other layer may be used as long as the layer can insulate the optical waveguide structure including the optical waveguide 187 and the optical coupler 218, etc from the semiconductor substrate 144. In place of the rectifying layer 180 and the semi-insulating semiconductor layer 212, for example, oxide layers, or insulation films ~~layers~~, such as sufficiently thick non-doped semiconductor layers, etc., may be formed. Plural kinds of such insulation films ~~layers~~ are laid to thereby insulate the optical waveguide structure from the semiconductor substrate 144.

Please amend the paragraph on page 119, beginning at line 4 as follows:

In the ninth to the eleventh embodiments, the MQW active layer 162 is formed on the wavelength ~~control~~ tuning layer 158 with the intermediate layer 160 formed therebetween, but the positions of the wavelength ~~control~~ tuning layer 158 and the MQW active layer 162 may be exchanged. That is, the wavelength ~~control~~ tuning layer 158 may be formed on the MQW active layer 162 with the intermediate layer 160 formed therebetween, and in this constitution, current is injected into the MQW active layer 162 from the p type electrode 152 formed on the underside of the semiconductor substrate 144. In this case, when the current is injected into the MQW active layer 162, the rectifying layer 180 or the semi-insulating semiconductor layer 212 suppress the generation of leak current which flows from the semiconductor substrate 144 to the earth potential through the

core layer 184 of the optical waveguide 187 and the n type InP buried layer 170 on both sides of the core layer 184. Accordingly, the decrease of the effectiveness of the current injection into the MQW active layer 162 of the TTG-LD 175 can be suppressed, and the TTG-LD 175 and the optical waveguide 187 can be integrated on one and the same substrate without characteristic deterioration.